MONTHLY NOTICES

OF THE

ROYAL ASTRONOMICAL SOCIETY.

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EDWIN DUNKIN, F.R.S., President, in the Chair.

Lieut. Sidney Gerald Burrard, R.E., Dehra Dun, India;
Rev. James Hardy Honeyburne, M.A., 97 Mulgrave Street, Liverpool;
James McKerrow, Surveyor-General of New Zealand, Wellington, N.Z.
John A. Westwood Oliver, Braehead House, Lochwinnoch, N.B., and 13 Bruton Street, Berkeley Square, W.; and
Major Harry T. Watson, Langley House, Slough, Bucks,

were balloted for and duly elected Fellows of the Society.

On an Observation of the Projection of Jupiter's First Satellite on its own Shadow, made at Dun Echt, Aberdeen. By Dr. R. Copeland.

(*Communicated by the Earl of Crawford and Balcarres.*)

While sketching *Jupiter* on February 18, 1885, I saw an exceedingly black short line extending east and west, slightly to the north of the planet's equator. In moments of the best definition it seemed lenticular (bi-convex) in shape. On consulting the *Nautical Almanac*, however, it turned out to be really the shadow of Satellite I. on the planet, almost totally occulted by the satellite itself. A sketch was made representing the appearance about $11^h\ 45^m$ G.M.T., as seen with a power of 229 on the 15-inch Equatorial. As the satellite approached *Jupiter's* preceding limb it came out quite bright and large, with a mere crescent of the shadow showing on its southern edge.

The great "red" spot was distinctly visible, although it is now of a pale sandy colour, somewhat whiter along its major axis. It exhibits a certain amount of delicate structure parallel to its margin. The red spot was on the central meridian at $12^h\ 10^m$ G.M.T.

As the opposition of *Jupiter* occurred at 8 A.M. on February 19, it seemed not improbable that the transit of the 2nd satellite on that day, and of the 1st satellite on the 20th, might also be attended by a partial concealment of their shadows. Telegraphic notice was accordingly sent to several correspondents inviting co-operation.

Near the middle of the transit of the 2nd satellite's shadow on the 19th, the shadow seemed almost perfectly round, the satellite being indistinguishable without an exact knowledge of its position. It was not until about half an hour before the egress, when the satellite began to be plainly visible, that it appeared to encroach upon its shadow to an appreciable extent. In this instance, therefore, the diminution of the shadow seems to have been quite as much due to the irradiation of light around the relatively bright satellite, as to an actual occultation of the shadow. A second drawing was made showing the slight deformation of the shadow, and also giving the detail of the belts as they appeared about $14^h\ 15^m$ G.M.T. The observed Greenwich mean times at egress were:

		h m s
II.	Tr. E. begins	14 28 8
II.	Tr. E. ends	14 32 53
II.	Sh. E. ends	14 33 53

Dun Echt Observatory:
1885, *April* 6.

Occultation of Aldebaran, 1885, *February* 22, *observed at Dun Echt, Aberdeen.* By Dr. R. Copeland.

(*Communicated by the Earl of Crawford and Balcarres.*

Occultation of Aldebaran, 1885, *February* 22.

	Dun Echt M.T.	Instrument.	Power.	Observer.
	h m s			
Disappearance	4 56 0·1	15-in. Grubb	132	Ralph Copeland
Reappearance	5 [52] 39·9	,,	,,	,,
Disappearance	4 56 0·35	6-in. Simms	94	J. G. Lohse
Reappearance	5 52 41·2	,,	,,	,,

In each case the phenomenon was instantaneous. A strong gale was blowing at the time.

The time of reappearance was recorded, at the 15-inch, one minute later than that given, which agrees with the computed time and with Mr. Lohse's observation.

Dun Echt Observatory:
1885, *April* 6.

Occultations of Stars by the Moon in the years 1876–1880, *and resulting Final Equations between the Errors of the Tables and the Errors of Observation.* By G. L. Tupman.

The place of observation was a few hundred yards east of the Royal Observatory, Greenwich. The chronometer employed (Fletcher 1050) was compared, by the intervention of another, with the sidereal standard clock of the Royal Observatory, a few hours before and after every recorded occultation. The Greenwich mean times have been calculated in the usual way from the sidereal time at mean noon given in the *Nautical Almanac*.

The telescope generally used was an Equatorial of $4\frac{1}{2}$ inches aperture, furnished with position circle and crossed-bar micrometer with power 66. For observing emersions one of the bars was placed to cut off a small segment of the Moon's limb at the expected point of reappearance of the star.

The final equations between the errors of Hansen's Tables and the errors of observation have been calculated by the method employed at the Royal Observatory, described in the Introduction to the *Greenwich Observations* and in Main's *Spherical Astronomy*.

The observed time is supposed to be increased by t^s; the star's Right Ascension and North Polar Distance by e'' and f'' (seconds of arc); the Moon's R.A. and N.P.D. by x'' and y''; and the parallax and semidiameter are supposed to be multiplied by $\left(1+\frac{m}{1000}\right)$ and $\left(1+\frac{n}{1000}\right)$ respectively.

The Moon's Right Ascension and North Polar Distance were interpolated, with second differences, from the hourly ephemeris in the *Nautical Almanac*, which did not, in these years, include Professor Newcomb's correction. The Equatorial horizontal parallax and semidiameter were interpolated, also with second differences, from the same work.

The apparent places of the stars have been taken, generally, from the section "Elements of Occultations" in the *Nautical Almanac*. For the smaller stars the mean places were brought up from the catalogues indicated, and the reductions to apparent place computed by means of the "Independent Constants." The final equations have been computed for such stars because it is probable, from the brightness of the stars, that modern observations of them will, before long, be obtainable.

In the calculation of the geocentric place of the "Corresponding Point" on the Moon's limb, the place of observation (except for the first one) has been assumed to be in

		h	m	s	
Longitude		0	0	2·62	East of the Royal Observatory.
		°	′	″	
Astronomical Latitude		51	28	34·8	N.
Geocentric Latitude...		51	17	21·2	

which latitude was obtained by triangulation from the Royal Observatory. Thirteen pairs of stars observed by Talcott's method in 1880 with the Zenith Telescope belonging to the Society gave the mean result:

$$51^\circ\ 28'\ 35''{\cdot}8 \pm 0''{\cdot}4.$$

1876, *April* 7.—Disappearance of BAC 4225 at the Moon's bright limb,* observed from the South Ground of the Royal Observatory with detached telescope; wind troublesome; star faint; near Moon's south limb:

	h	m	s	
Greenwich Mean Solar Time	8	27	52·0	
Star's App. R.A.	12	25	17·78.	N.P.D. 94° 22′ 19″·6 (N.A.)

Final Equation ... ... $+1''{\cdot}02 = -{\cdot}1088\,(e''-x'') - {\cdot}2280t + {\cdot}9940f'' - 2{\cdot}5919m - {\cdot}9940y'' - {\cdot}9305n$

1877, *February* 26.—Disappearance of *a Leonis* at the dark limb:

	h	m	s	
G.M.T.	12	45	44·67	
Star's App. R.A.	10	1	51·51.	N.P.D. 77° 26′ 4″·1 (N.A.)

Final Equation ... ... $+11''{\cdot}53 = +{\cdot}8498\,(e''-x'') - {\cdot}4987t + {\cdot}4884f'' - 0{\cdot}5132m - {\cdot}4876y'' - {\cdot}9988n$

1877, *February* 26.—Reappearance of *a Leonis* at the bright limb:

	h	m	s	
G.M.T.	13	51	8·46.	"Late."

Final Equation ... ... $-10''{\cdot}43 = -{\cdot}7518\,(e-x) + {\cdot}5193t - {\cdot}6349f + 0{\cdot}5099m + {\cdot}6355y - {\cdot}9987n$

* Because nearly full.

1878, *May* 5.—Disappearance of Yarnall 2332 at the dark limb:

	h m s	
G.M.T.	8 16 26·09	
Star's App. R.A.	5 31 21·92.	N.P.D. 63° 27′ 9″·1 (Yarnall)
Final Equation	+17″·34 =	+·6193 $(e-x)$ − ·4210t
		+·7182f −0·1743m
		−·7170y − ·9282n

1878, *May* 5.—Disappearance of Yarnall 2355 at the dark limb:

	h m s	
G.M.T.	9 15 14·92	
Star's App. R.A.	5 34 1·51.	N.P.D. 63° 26′ 51″·9 (Yarnall)
Final Equation	+19″·00 =	+·8033 $(e-x)$ − ·5450t
		+·4284f +0·8071m
		−·4266y − ·9285n

1878, *November* 10.—Disappearance of η *Tauri* at the bright limb:

	h m s	
G.M.T.	11 11 5·05.	"Very good."
Star's App. R.A.	3 40 19·27.	N.P.D. 66° 16′ 3″·9 (N.A.)
Final Equation	+4″·26 =	+·7593 $(e-x)$ − ·2335t
		+·5546f −1·3713m
		−·5532y − ·8976n

1878, *November* 10.—Reappearance of 20 *Tauri* at the dark limb: 21^h after full moon:

	h m s	
G.M.T.	11 21 46·05.	"Pretty good."
Star's App. R.A.	3 38 39·37.	N.P.D. 66° 0′ 32″·5 (N.A.)
Final Equation	−7″·26 =	−·8414 $(e-x)$ + ·2856t
		−·3819f +1·0508m
		+·3835y − ·8977n

1879, *March* 2.—Disappearance of 139 *Tauri* at the dark limb:

	h m s	
G.M.T.	4 52 39·32.	"Full daylight: star held steadily until extinguished."
Star's App. R.A.	5 50 31·40.	N.P.D. 64° 3′ 40″·2 (N.A.)
Final Equation	+6″·50 =	+·8126 $(e-x)$ − ·3605t
		+·4203f −1·7390m
		−·4185y − ·9149n

1879, *March* 2.—Reappearance of 139 *Tauri* at the bright limb:

	h m s	
G.M.T.	6 4 32·21.	"Excellent."
Final Equation	$-5''\cdot16 = -\cdot8172\,(e-x) + \cdot3430t$	
	$+\cdot4105f \quad -0\cdot0665m$	
	$-\cdot4087y \quad -\cdot9155n$	

1879, *March* 3.—Disappearance of ω *Geminorum* at the dark limb:

	h m s	
G.M.T.	9 18 46·84	
Star's App. R.A.	6 55 4·88.	N.P.D. 65° 36′ 46″·4 (N.A.)
Final Equation	$+4''\cdot89 = +\cdot8364\,(e-x) - \cdot3146t$	
	$-\cdot3911f \quad +1\cdot1977m$	
	$+\cdot3929y \quad -\cdot9308n$	

1879, *March* 3.—Reappearance of ω *Geminorum* at the bright limb:

	h m s	
G.M.T.	10 16 16·43.	"Star just clear."
Final Equations	$-5''\cdot81 = -\cdot4865\,(e-x) + \cdot3290t$	
	$-\cdot8442f \quad +0\cdot8112m$	
	$+\cdot8448y \quad -\cdot9314n$	

1879, *March* 30.—Disappearance of BAC 2154 at the dark limb:

	h m s	
G.M.T.	7 16 4·13.	"Near south limb."
Star's App. R.A.	6 30 4·54.	N.P.D. 65° 18′ 36″·9 (N.A.)
Final Equation	$+1''\cdot26 = +\cdot2145\,(e-x) - \cdot1766t$	
	$+\cdot9717f \quad -1\cdot3374m$	
	$-\cdot9715y \quad -\cdot9140n$	

1879, *April* 26.—Disappearance of BB. VI.+24°, 1263 at the dark limb:

	h m s	
G.M.T.	9 8 51·93	
Star's App. R.A.	6 18 52·75.	N.P.D. 65° 11′ 43″·3 (BB. VI.)
Final Equation	$+9''\cdot58 = +\cdot9030\,(e-x) - \cdot4812t$	
	$+\cdot0251f \quad +1\cdot9605m$	
	$-\cdot0231y \quad -\cdot9044n$	

1879, *May* 3.—Disappearance of *q Virginis* at the dark limb:

	h	m	s	
G.M.T.	9	19	33·17	
Star's App. R.A.	12	27	34·88.	N.P.D. 98° 47′ 24″·8 (N.A.)

Final Equation ... ... $+9''\cdot26 = +\ 8997\ (e-x) - \cdot2546t$
$-\cdot4178f \quad +1\cdot1153m$
$+\cdot4172y \quad -\ \cdot9953n$

1879, *July* 28.—Disappearance of *α Scorpii* at the dark limb:

	h	m	s	
G.M.T.	9	37	39·34.	"Almost instantaneous."
Star's App. R.A.	16	22	3·45.	N.P.D. 116° 9′ 56″·6 (N.A.)

Final Equation ... ... $+5''\cdot58 = +\cdot4055\ (e-x) - \cdot1756t$
$-\cdot8941f \quad +3\cdot4441m$
$+\cdot8937y \quad -\ \cdot9726n$

1879, *July* 28.—Reappearance of *α Scorpii* at the bright limb:

	h	m	s	
G.M.T.	10	6	45·88.	"Instantaneous; near the north limb."

Final Equation ... ... $-2''\cdot43 = -\cdot3258\ (e-x) + \cdot1840t$
$-\cdot9327f \quad +2\cdot6675m$
$+\cdot9325y \quad -\ \cdot9725n$

1879, *August* 25.—Disappearance of Bradley 2174 at the dark limb:

	h	m	s	
G.M.T.	8	5	38·71	
Star's App. R.A.	17	6	45·92.	N.P.D. 116° 50′ 26″·3 (N.A.)

Final Equation ... ... $+15''\cdot23 = +\cdot8596\ (e-x) - \cdot4192t$
$-\cdot2950f \quad +1\cdot6678m$
$+\cdot2930y \quad -\ \cdot9644n$

1879, *October* 24.—Disappearance of *θ Aquarii* at the dark limb:

	h	m	s	
G.M.T.	7	12	38·28.	"Hardly instantaneous."
Star's App. R.A.	22	10	31·00.	N.P.D. 98° 22′ 44″·5 (N.A.)

Final Equation ... ... $+12''\cdot04 = +\cdot6310\ (e-x) - \cdot3773t$
$-\cdot7712f \quad +1\cdot9596m$
$+\cdot7710y \quad -\ \cdot9179n$

1879, *November* 18.—Disappearance of σ *Capricorni* at the dark limb:

	h m s	
G.M.T.	6 35 41·39	
Star's App. R.A.	20 12 28·21.	N.P.D. 109° 29′ 32″·7 (N.A.)
Final Equation	+ 11″·12 =	+ ·9393 $(e-x)$ − ·4412t
		− ·1332f + 1·6171m
		+ ·1316y − ·9593n

1879, *December* 22.—Disappearance of 101 *Piscium* at the dark limb:

	h m s	
G.M.T.	5 6 58·20	
Star's App. R.A.	1 29 22·92.	N.P.D. 75° 56′ 58″·6 (N.A.)
Final Equation	+ 5″·59 =	+ ·8608 $(e-x)$ − ·2178t
		+ ·4569f − 1·9730m
		− ·4561y − ·8911n

1880, *January* 19.—Disappearance of BB. VI. + 17°, 327 at the dark limb:

	h m s	
G.M.T.	8 43 7·58	
Star's App. R.A.	2 6 0·01.	N.P.D. 72° 32′ 22″·0 (BB. VI.)
Final Equation	+ 5″·08 =	+ ·8865 $(e-x)$ − ·2894t
		+ ·3616f + 0·4656m
		− ·3604y − ·8919n

1880, *February* 12.—Disappearance of κ *Piscium* at the dark limb:

	h m s	
G.M.T.	5 32 28·31	
Star's App. R.A.	23 20 47·13.	N.P.D. 89° 24′ 2″·4 (N.A.)
Final Equation	+ 10″·14 =	+ ·4352 $(e-x)$ − ·3880t
		− ·9003f + 3·1440m
		+ ·9003y − ·9323n

1880, *February* 17.—Disappearance of WB_2 III. 538 at the dark limb:

	h m s	
G.M.T.	8 39 54·3	
Star's App. R.A.	3 27 29·80.	N.P.D. 67° 38′ 31″·2 (WB_2)
Final Equation	+ 8″·93 =	+ ·8806 $(e-x)$ − ·3522t
		+ ·2948f + 0·8508m
		− ·2932y − ·8891n

1880, *February* 17.—Disappearance of WB_2 III. 554 at the dark limb:

	h m s	
G.M.T.	9 18 37·3.	"Near north limb."
Star's App. R.A.	3 27 53·51.	N.P.D. 67° 17′ 58″·1 (WB_2)
Final Equation	$+2''{\cdot}65 =$	$+{\cdot}2733\,(e-x) - {\cdot}1646t$
		$-{\cdot}9549f \quad +2{\cdot}2962m$
		$+{\cdot}9551y \quad -{\cdot}8890n$

1880, *February* 17.—Disappearance of BB. VI.+22°, 516 at the dark limb:

	h m s	
G.M.T.	9 48 50·3	
Star's App. R.A.	3 29 31·95.	N.P.D. 67° 28′ 15″·6 (BB. VI.)
Final Equation	$+2''{\cdot}52 =$	$+{\cdot}9064\,(e-x) - {\cdot}4200t$
		$-{\cdot}1707f \quad +2{\cdot}1069m$
		$+{\cdot}1725y \quad -{\cdot}8890n$

1880, *March* 13.—Disappearance of 101 *Piscium* at the dark limb:

	h m s	
G.M.T.	7 34 35·98	
Star's App. R.A.	1 29 22·03.	N.P.D. 75° 57′ 4″·3 (N.A.)
Final Equation	$+6''{\cdot}89 =$	$+{\cdot}9612\,(e-x) - {\cdot}4485t$
		$+{\cdot}1092f \quad +1{\cdot}7744m$
		$-{\cdot}1080y \quad -{\cdot}9047n$

1880, *March* 15.—Disappearance of DM+21°, 426 at the dark limb:

	h m s	
G.M.T.	6 43 42·39	
Star's App. R.A.	3 6 22·30.*	N.P.D. 68° 49′ 25″·0 (D.M.)
Final Equation	$-15''{\cdot}08 =$	$+{\cdot}9270\,(e-x) - {\cdot}3946t$
		$-{\cdot}0657f \quad +1{\cdot}6381m$
		$+{\cdot}0675y \quad -{\cdot}8919n$

* The star's R.A. evidently requires a correction of about $-1^s{\cdot}5$.

1880, *March* 17.—Disappearance of BAC 1518 at the dark limb:

	h m s	
G.M.T.	6 12 21·34	
Star's App. R.A.	4 48 58·75.	N.P.D. 65° 36′ 3″·5 (N.A.)
Final Equation	$+5''{\cdot}92 =$	$+{\cdot}8870\,(e-x) - {\cdot}3477t$
		$+{\cdot}2119f \quad +0{\cdot}2466m$
		$-{\cdot}2101y \quad -{\cdot}8879n$

1880, *March* 17.—Disappearance of WB_2 IV. 1193 at the dark limb:

	h	m	s		
G.M.T.	9	21	58·58		
Star's App. R.A.	4	54	18·43.	N.P.D. 65° 31′ 44″·6	(WB_2)
Final Equation	+ 12″·80 =		+ ·8616 ($e-x$)	− ·3965t	
			− ·3100f	+ 2·3103m	
			+ ·3118y	− ·8880n	

1880, *March* 17.—Disappearance of DM+24°, 730 at the dark limb:

	h	m	s		
G.M.T.	9	46	43·89		
Star's App. R.A.	4	55	5·89.	N.P.D. 65° 41′ 14″·4	(D.M.)
Final Equation	+ 20″·36 =		+ ·8728 ($e-x$)	− ·4375t	
			+ ·2727f	+ 1·2746m	
			− ·2709y	− ·8880n	

1880, *March* 17.—Disappearance of WB_2 IV. 1227 at the dark limb:

	h	m	s		
G.M.T.	10	13	7·79		
Star's App. R.A.	4	55	28·45.	N.P.D. 65° 51′ 26″·4	(WB_2)
Final Equation	+ 0″·55 =		+ ·4403 ($e-x$)	− ·2594t	
			+ ·8746f	− 0·8815m	
			− ·8742y	− ·8880n	

1880, *March* 17.—Disappearance of DM+24°, 738 at the dark limb:

	h	m	s		
G.M.T.	10	15	44·89		
Star's App. R.A.	4	56	2·90.	N.P.D. 65° 41′ 46″·5	(D.M.)
Final Equation	+ 36″·64 =		+ ·8829 ($e-x$)	− ·4664t	
			+ ·2304f	+ 1·4320m	
			− ·2286y	− ·8880n	

1880, *March* 17.—Disappearance of 103 *Tauri* at the dark limb:

	h	m	s		
G.M.T.	12	30	21·91		
Star's App. R.A.	5	0	49·62.	N.P.D. 65° 53′ 36″·3	(N.A.)
Final Equation	+ 5″·68 =		+ ·7248 ($e-x$)	− ·4583t	
			+ ·6018f	− 0·0073m	
			− ·6006y	− ·8881n	

1880, *March* 21.—Disappearance of d^2 *Cancri* at the dark limb:

	h	m	s		
G.M.T.	7	16	25·69		
Star's App. R.A.	8	19	4·87.	N.P.D. 72° 33′ 42″·3 (N.A.)	
Final Equation	$+6''{\cdot}24 =$		$+{\cdot}9294\,(e-x)-$	·3153t	
			$-{\cdot}2128f$	$-0{\cdot}1605m$	
			$+{\cdot}2142y$	$-{\cdot}9127n$	

1880, *April* 16.—Disappearance of WB_2 VII. 326 at the dark limb:

	h	m	s		
G.M.T.	8	52	23 73		
Star's App. R.A.	7	12	7·54.	N.P.D. 68° 49′ 5″·7 (WB_2)	
Final Equation	$+2''{\cdot}76 =$		$+{\cdot}9290\,(e-x)-$	·3947t	
			$-{\cdot}0139f$	$+1{\cdot}6032m$	
			$+{\cdot}0157y$	$-{\cdot}8944n$	

1880, *April* 16.—Disappearance of BB. VI.+21°, 1575 at the dark limb:

	h	m	s		
G.M.T.	9	20	3·95		
Star's App. R.A.	7	12	54·25.	N.P.D. 68° 56′ 27″·2 (BB. VI.)	
Final Equation	$+3''{\cdot}89 =$		$+{\cdot}9107\,(e-x)-$	·4331t	
			$+{\cdot}2009f$	$+1{\cdot}2864m$	
			$-{\cdot}1992y$	$-{\cdot}8945n$	

1880,–*April* 16.—Disappearance of 56 *Geminorum* at the dark limb:

	h	m	s		
G.M.T.	10	42	59·47		
Star's App. R.A.	7	14	54·10.	N.P.D. 69° 19′ 53″·3 (N.A.)	
Final Equation	$+4''{\cdot}72 =$		$+{\cdot}4055\,(e-x)-$	·3403t	
			$+{\cdot}9003f$	$-1{\cdot}1371m$	
			$-{\cdot}8999y$	$-{\cdot}8949n$	

Occultations observed at Forest Lodge, Maresfield.
By Captain W. Noble.

1885, *March* 27.—BAC 3529. The sky was slightly hazy, and the Star, which was not particularly well defined, did not go out sharply and suddenly, but rather faded out at the Moon's dark limb at $10^h\ 24^m\ 44^s{\cdot}5$ local mean time$=10^h\ 24^m\ 26^s{\cdot}7$ G.M.T. It was at some distance from the bright limb ere it was caught at reappearance.

43 *Leonis.* Subsequently disappeared quite instantaneously at the dark limb at $11^h\ 36^m\ 56^s{\cdot}1$ L.M.T.$=11^h\ 36^m\ 38^s{\cdot}3$ G.M.T. Power 255 adjusted on the first star.

March 28.—BAC 3836. This star disappeared at the dark limb of the Moon in much the same odd way that BAC 3529 did last night; not going out instantaneously, but rather fading out at $10^h\ 19^m\ 42^s{\cdot}6$ L.M.T.$=10^h\ 19^m\ 22^s{\cdot}8$ G.M.T. Power 154 adjusted on the star.

I only put these observations on record on account of the odd behaviour of the two stars BAC 3529 and BAC 3836. The effect in the latter case was precisely that which would have been presented had the star had a measurable objective disc (instead of its mere diffraction one) and a conical mountain on the Lunar limb had passed obliquely over it.

Forest Lodge, Maresfield, Uckfield:
1885, *April* 9.